

Mechanical study of “AMANDA”



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Introduction

Material properties of Niobium (RRR~250)

- Density: 8.57 g.m^{-3}
- Young's Modulus: 107 GPa
- Poisson's ratio: 0.394
- Yield strength : ~70 MPa @ 300K
- Tensile strength : ~150 MPa @ 300K

Calculations performed with ACORD-CP

- Yield strength limit: 50 MPa
- Only linear → Von Mises stress values > 70 MPa are wrong !

Under vacuum load @ 1 bar

Cavity without stiffeners

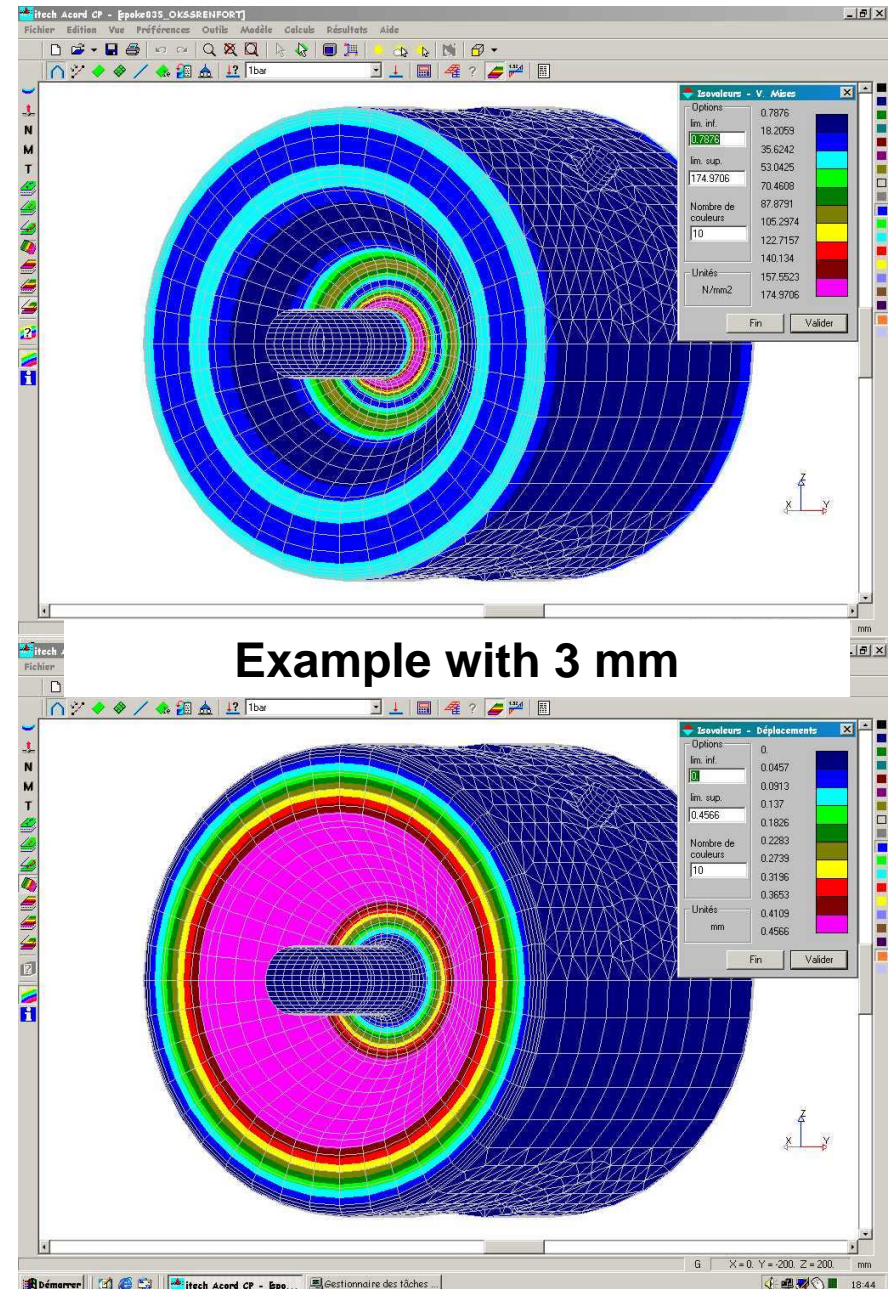
Thickness (mm)	Peak V.M stress (MPa)
2	372
3	175
4	102
5	67

Yield strength exceeded

Cost : 3600€/mm & 8 kg



!!! Stiffeners !!!



Under vacuum load @ 1 bar

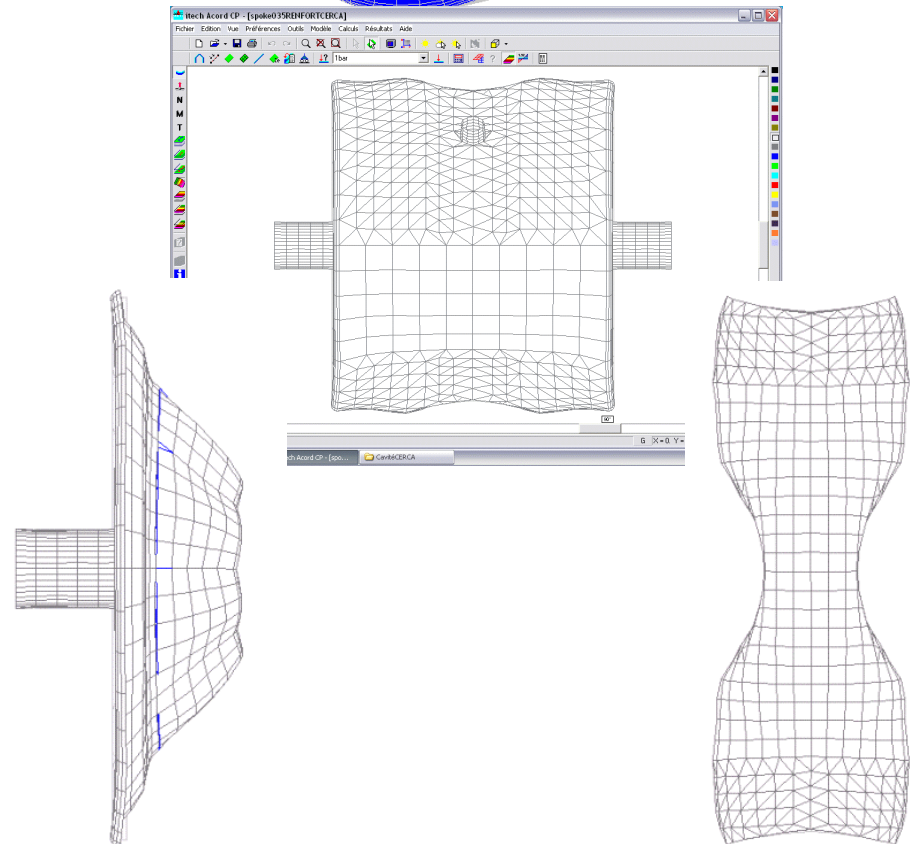
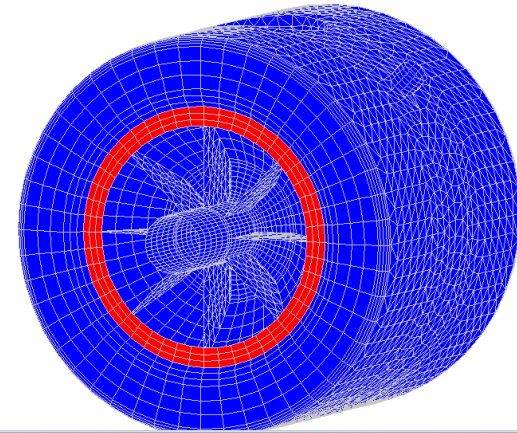
Thickness: 3 mm

Cavity with 8 stiffeners
& a ring (2 mm thick)

Peak V.M stress (MPa)	Peak displacement (mm)
37.3	0.057

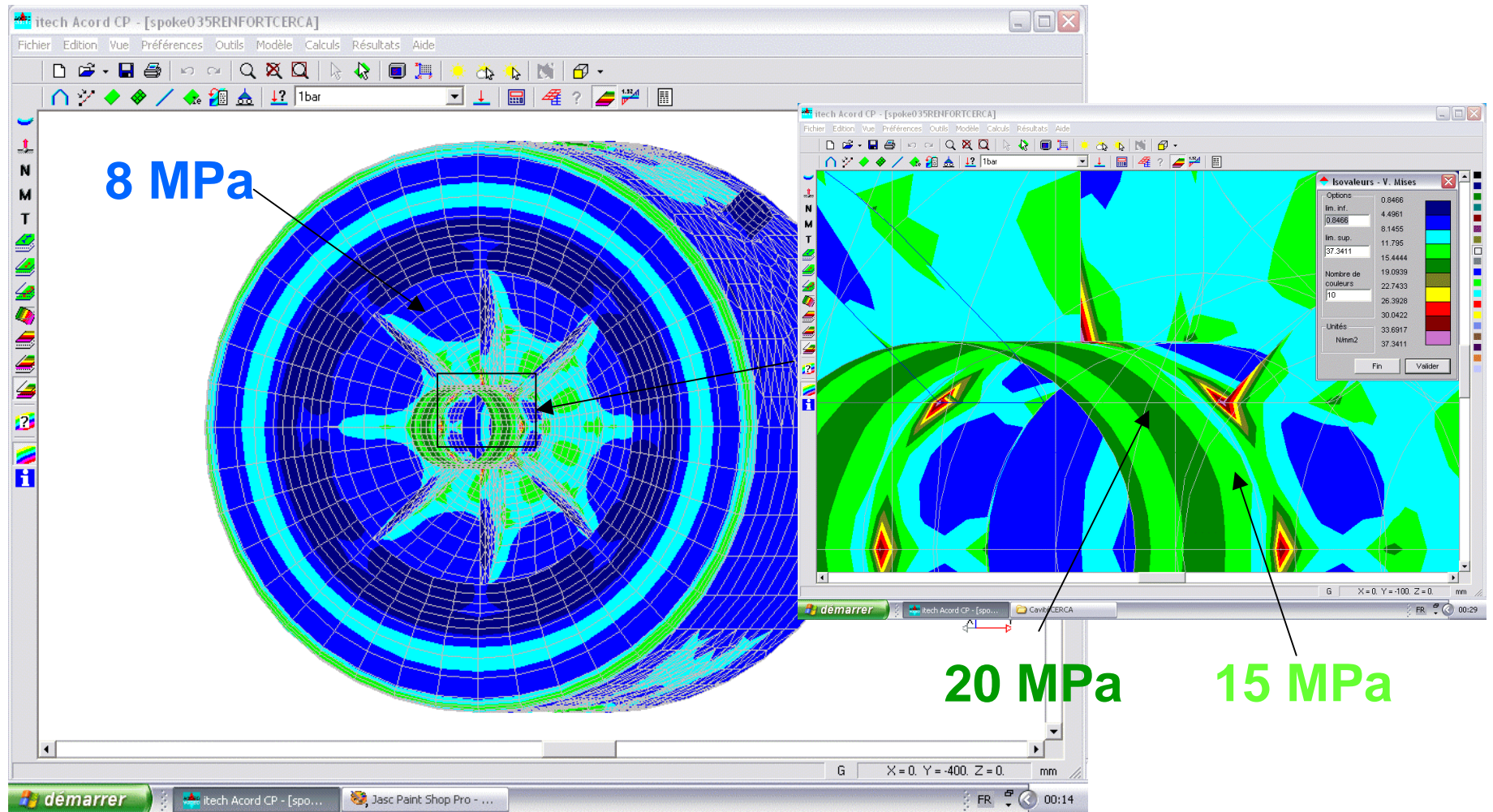
NB: Both beam tube ends fixed

No change with thicker
stiffeners (3 mm to 5 mm)



Under vacuum load @ 1 bar

Location of stress



Under vacuum load @ 1 bar

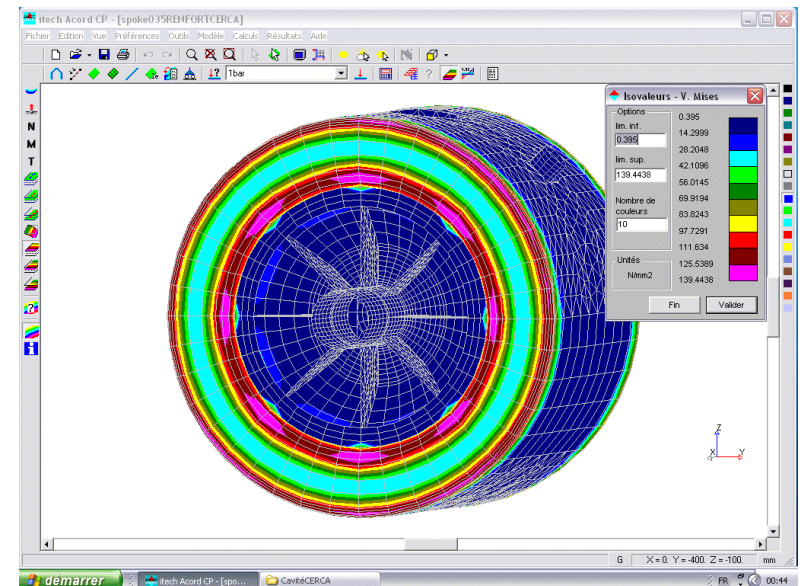
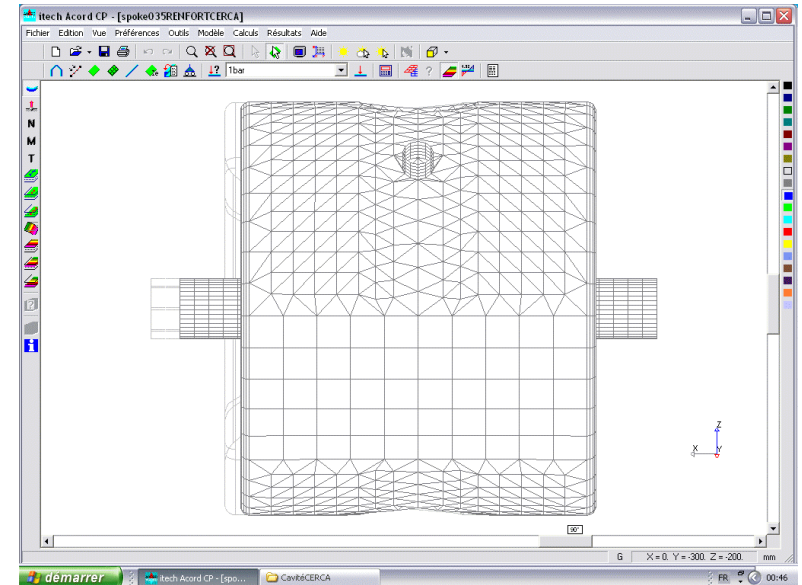
Calculations with one end free

Peak V.M stress (MPa)	Peak displacement (mm)
139	2.38



We need to fix the cavity under vacuum load

So we used the test bench designed for the 5-cell cavity



Tuning

Cavity stiffness value

- 50 MPa reached for 0.86 mm
- 3500 N/mm

measurements

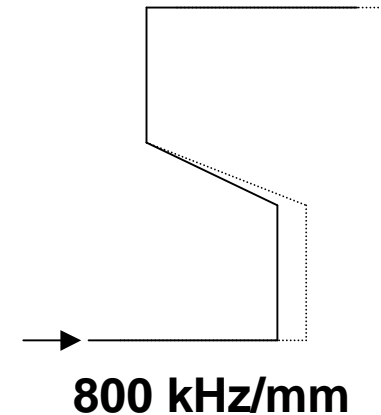
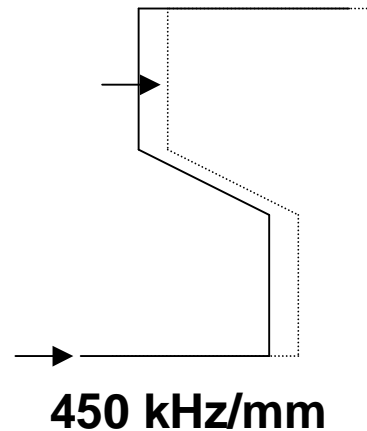
~2500 N/mm (error: 40%)

Sensitivity

- between 450 and 800 kHz/mm
(estimation with MAFIA)

measurements

~550 kHz/mm



Vibration modes

Frequencies in Hz of the first modes

Mode 1	97	→	Torsion/beam axis
Mode 2	149	→	Oscillation along the beam axis
Mode 3	287	}	Deformations
Mode 4	303		
Mode 5	336		

NB: Both beam tube ends fixed

→ **NO DANGER ?**

Conclusion

- Cavity is OK for cryogenic test ($P \sim 1$ bar in cryostat)
- Cavity is probably not OK in an “accelerator” configuration (P up to 2 bars during cool down)
→ New stiffeners (in study)

Discussion

- Advantages & Drawbacks in comparison with the stiffening ring option ?

